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(54) FLATTENING AND HAUL-OFF APPARATUS FOR BLOWN TUBULAR PLASTICS FILM

- (71) We, WINDMOLLER & HOLSCHER, a German Company, of 48—52 Münsterstrasse, 454 Lengerich, Westphalia, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- The invention relates to a flattening and haul-off apparatus for blown tubular plastics film produced on a stationary blowhead, the apparatus comprising haul-off rolls and flattening means such as plates mounted for oscillation about the longitudinal axis of the arriving tubular film.
- In the manufacture of thermoplastic film gauge variations are inevitable. When such film is then wound up, the thicker portions in each turn of the coil build up to form annular ridges or beads which give rise to permanent deformation of the film and, when the film is later unwound, it will no longer lie completely flat, thereby making it difficult to print the film or to work on it to form packaging material or other products, for example tubular sections to be made into bags.
- With blown tubular film or with flat films produced by longitudinally cutting a tubular film the annular ridges or beads in the coils and the disadvantages accruing therefrom can be avoided if relative rotation is produced between the blowhead on the one hand and the flattening and haul-off mechanism on the other hand. Such rotation may be continuous or oscillatory with the direction of rotation being reversed after every 360°. Such rotation causes the gauge variations in the film to be distributed over the entire width of the coil much in the same manner as a rope is coiled on a drum and therefore the cylindrical coils of film will not exhibit annular bulges.
- There are several ways of achieving relative rotation between the blowhead and the haul-off device. In one example the blowhead is connected to an extruder for the film by means of a rotary coupling, suitable sealing elements being provided to prevent linkage of the plastics material at the coupling. However, production needs to be interrupted rather frequently for the purpose of replacing the sealing elements which are subjected not only to high temperatures but also to high pressures from the plastics material (about 200 to 300 kilopond per square centimeter). Also, by turning the blowhead it is possible to distribute only the gauge variations caused by the blowhead itself, not those caused by irregular flow in the conduit, which may be an elbow leading to the blowhead, as a result of uneven temperatures in the conduit. Such errors in flow always become evident in the same position at the outlet from the blowhead and therefore still give rise to annular bulges when the film is subsequently coiled. Another difficulty is the need for electrifying the blowhead through slip rings or trailing cables which are liable to become damaged under the high temperatures that are encountered.
- Distribution of all the gauge variations that arise either in the blowhead or in the supply passages thereto can be achieved only if the entire extruder is rotated together with the blowhead and cooling ring or if the haul-off and flattening apparatus is rotated. Thus, the extruder and the blowhead connected thereto with its cylinder vertical can be mounted on a turntable in a manner such that the cylinder axis, extrusion head axis and tubular film axis coincide with the rotary axis of the turntable. The turntable also carries a drive motor, a temperature control box and an air cooling ring for the film. Power supply to the extruder which oscillates through 360° is effected by means of trailing cables or flexible tubes. As an alternative embodiment, the extruder can be stationary and have an oscillating conveyor cylinder carrying the blowhead, the conveyor cylinder being vertical or horizontal. Whether the extruder be stationary or oscillatory, it is a special construction

[Price 25p]

designed for making blown film and not suitable for other uses such as making flat films through elongated nozzles in the form of slots. Further, there are practical reasons such as a limited factory height for restricting the extruders to a medium size and thereby limiting the maximum output.

Finally, it is possible to rotate the haul-off and flattening apparatus whilst the extruder is stationary. For this, it is essential that the film be coiled immediately after being hauled off by means of a winder that rotates together with the haul-off apparatus and which must be stopped whenever a reel is changed. It is of course not possible to supply the film direct to some other machine such as a printing press without first coiling it. It is also disadvantageous that the heavy coils of film must be hoisted from an elevated platform on which the haul-off apparatus is mounted to the floor of the factory where subsequent processing takes place.

The invention aims to provide a flattening and haul-off apparatus for blown tubular plastics film produced on a stationary blowhead in which gauge variations caused in the blowhead or by irregular flow in the supply passages are evenly distributed over the width of the film, which does not unduly limit the use of the extruder, does not take up an uneconomically large space, does not present problems with regard to power supply and which can be used as desired for supplying the film either directly to another processing machine or to a stationary winder.

According to the invention, a flattening and haul-off apparatus for blown tubular plastics film produced on a stationary blowhead comprises flattening means and haul-off rolls mounted for oscillation about the longitudinal axis of the arriving tubular film, a turning bar for the film located downstream of the haul-off rolls and disposed at substantially 45° to the axis of oscillation, a first direction-changing roll for the film located downstream of the turning bar and disposed substantially parallel to the axis of oscillation, the turning bar and first direction-changing roll both being mounted to oscillate with the haul-off rolls, and a non-oscillatory second direction-changing roll located downstream of the first direction-changing roll and disposed substantially parallel to the said axis of oscillation. Thus, the flattened film is turned at right-angles to the haul-off direction and is laterally fed to the non-oscillatory second direction-changing roll, which is preferably one of a pair of rolls, after which it can be fed to a stationary winder or to a processing machine.

In one form of the invention, the turning bar, the first direction-changing roll and a third direction-changing roll that is parallel

to the haul-off rolls and located upstream of the turning bar are mounted eccentric to the axis of oscillation, the second direction-changing roll being one of a pair of rolls and defining a nip or gap that is substantially in line with the axis of oscillation. This ensures that during oscillation there will always be a constant spacing between the turning bar (and the first direction-changing roll downstream thereof) and the axis of oscillation and thus the speed of the film will remain constant. In a second form of the invention which is somewhat simpler the turning bar is located above the haul-off rolls, the first direction-changing roll is one of a pair of rolls adjacent the turning bar and the second direction-changing roll is located eccentric to the axis of oscillation. In this case fluctuations in the film speed downstream of the first direction-changing roll are preferably compensated by a film winder which is driven through a slip clutch. Since the turning bar is located directly above the haul-off rolls one can dispense with at least the third direction-changing roll upstream of the turning bar. Above all, this form of the invention ensures that the angle of oscillation can be substantially 360° without undue constructional complications.

In using the apparatus of the invention, it is possible to employ conventional extruders, even the very large kind having a high output, with conventional blowheads without encountering difficulties in making the power and rotary connections. If the extruder is vertical, the haul-off and flattening apparatus can be disposed on an elevated platform of light construction because there is no longer the problem of having to lower the reels on which the film is wound since the winder is located at floor level. It is also possible to feed the tubular film direct to a processing machine without any pre-winding. Despite an upstanding blowhead and an upstanding air cooling ring for the film, all the gauge inaccuracies produced by the extruder, the parts connected to the blowhead, the blowhead itself and by the film cooling device are uniformly distributed to produce an absolutely cylindrical coil of film even if the gauge variations are large, this being a prerequisite for the efficient further processing of the film. It should also be emphasized that the apparatus of the invention calls for only a few simple components that are required to oscillate with the haul-off rolls. For example, the capital expenditure is considerably lower than for making a rotary connection for a blowhead or for an oscillatory winder.

It is preferred to provide a turning bar which is not rotatable about its own axis but has a low-friction surface. A rotary turning bar would exert an additional displacing force on the film in the longitudinal

direction of the turning bar. If the blown film emerges from the blowhead in a vertical direction so that the haul-off apparatus must be mounted on an elevated platform, it is advantageous to provide a second and stationary turning bar downstream of the second direction-changing roll and disposed at substantially 45° to the axis of oscillation, as well as non-oscillatory direction-changing rolls immediately upstream and downstream of this second turning bar. This makes it possible to locate the winder or further processing machine on the floor of the factory in the immediate vicinity of the extruder.

In the case of the aforementioned first form of the invention where the second direction-changing roll is one of a pair of rolls and the nip or gap defined thereby is substantially in line with the axis of oscillation, best results are obtained if the angle of oscillation is as near as possible to 360°. To permit such a large angle at little extra cost deflecting rolls for deflecting the film prior to the dead centre positions of oscillation may be provided downstream of the second direction-changing roll and upstream of the second turning bar. In the embodiment where the first turning bar is disposed above the haul-off rolls, the same purpose can be achieved by providing a deflecting roll for the film adjacent the turning bar on the opposite side thereof to the first direction-changing roll, the deflecting roll being mounted for rotation and oscillation and being effective to keep the film at an adequate distance from the turning bar at the dead centre positions of oscillation.

If, in this form of the invention, the film is fed to a processing machine instead of to a winder, a dancer roll or similar film take-up device can be located downstream of the second direction-changing roll and upstream of the processing machine for compensating speed fluctuations in the film. Naturally, such a take-up device can also be provided upstream of a winder that has no slip clutch and therefore turns at a constant speed. Further, a further direction-changing roll may be provided parallel to the first direction-changing roll, downstream thereof and upstream of the second direction-changing roll, this further roll being mounted at the location of a hinge connection between two levers which are respectively pivoted to the first and second direction-changing rolls. This construction is particularly useful for wide films which, because of possibly large spacings between the first and second direction-changing rolls, may have a tendency to sag under their own weight. Also, with this expedient it is unnecessary to compensate for film speed fluctuations in the aforementioned manner because the lever-mounted further direction-changing roll will effectively produce a path of constant length between

the first and second direction-changing rolls.

Examples of the invention will now be described with reference to the accompanying diagrammatic drawings, in which:—

Fig. 1 is a side elevation of an extruder for blown film equipped with a flattening and haul-off apparatus;

Fig. 2 is a plan view of the apparatus in the direction of the arrow II in Fig. 1;

Fig. 3 is a side view in the direction of the arrow III in Fig. 1;

Fig. 4 is a plan view corresponding to Fig. 2 but of a modified flattening and haul-off apparatus;

Fig. 5 is a side elevation of an extruder equipped with a second form of flattening and haul-off apparatus;

Figs. 6 and 7 are views taken respectively in the directions of the arrows II and III in Fig. 5; and

Fig. 8 is a modification of the Fig. 5 apparatus.

As shown in Fig. 1, a tubular plastics film 3 is made by an extruder 1 and blowhead 2. This film is flattened by flattening plates 4 and withdrawn by a pair of haul-off rolls 5 driven by a motor 6. The flattened film 7 is diverted by a direction-changing roll 8 which is adjacent the haul-off rolls 5 and parallel thereto, turned sideways through 90° by a non-rotary turning bar 9 which is at 45° to the longitudinal axis of the unflattened film 3, and then fed upright over a direction-changing roll 10 to pass through the longitudinal axis of the unflattened film 3 where it is guided by a pair of rotary direction-changing rolls 16 connected to a stationary support 15.

The haul-off rolls 5 and direction-changing rolls 8 and 10 are carried by a turntable 11 which is supported by a ball race 12 on an elevated platform 13 in the factory and which is oscillated by a motor 14. The power supply lines for electricity and possibly compressed air are omitted from the drawings for the purpose of clarity. There may be conventional trailing cables and hoses or slip rings and rotary pneumatic couplings. Means such as electric limiting switches for reversing the direction of rotation of the turntable 11 are also not shown.

The direction-changing rolls 16 together define a nip or gap that lies in line with the longitudinal axis of the unflattened tubular film 3. From these rolls, which do not oscillate together with the turntable 11, the flattened tubular film 7 passes over a non-oscillatory direction-changing roll 17 that is parallel to the rolls 16, a second turning bar 18 which is inclined at 45°, and a direction-changing roll 19. The parts 17, 18 and 19 are carried by the same support 15 which carries the rolls 16. After leaving the roll 19, the film has been turned through 90° and travels in a direction opposite to

the direction in which the unflattened film 3 arrived at the haul-off apparatus. With the aid of one or more guide rolls 20, the film then reaches a winder 21 which, in the illustrated embodiment, is in the form of a peripheral winder.

For clarity, the bearing 12 and drive motors 6 and 14 of Fig. 1 have been omitted from Fig. 2 which indicates the two limiting positions assumed by the turning bar 9 and roll 10 during oscillation in broken lines at 9¹, 10¹ and 9¹¹ and 10¹¹, respectively. The position shown for the bar 9 and roll 10 in full lines is an intermediate position and the heavy chain-dotted lines show the corresponding disposition of the folded film 7; the course of the film 7 when the turntable is in the limiting positions of oscillation is also visible in Fig. 2, namely in lighter chain-dotted lines extending from the rolls 16 to the roll positions 10¹ and 10¹¹, respectively. The principle of turning the film over the non-rotary but oscillatory turning bar 9 that is inclined at 45° is particularly clear from Fig. 3.

In the Figs. 1 to 3 embodiment of the apparatus, the angle of oscillation is limited to approximately 270 to 300° depending on the width of the film and also depending on the spacing of the parts 15, 17, 18 and 19 from the axis of oscillation which is coincident with the longitudinal axis of the unflattened film 3. Experience has shown that the distribution of gauge errors across the coil of film will in most cases be fully adequate with such limited rotation. However, if the gauge errors are severe and especially if they are concentrated on one side of the film, uniform distribution of the gauge errors is facilitated if the angle of oscillation is increased to 360°, this being possible without unduly complicated modifications, as shown in Fig. 4. In this case, the non-oscillatory central direction-changing rolls 16 are followed by deflecting rolls 25 and 26 as viewed in the direction of film travel. These deflecting rolls work on the principle of dancer rolls which deflect the film laterally before the turntable 11 has reached its dead centre positions of oscillation. For the purpose of clarity, the non-oscillatory support 15 and its fittings have been omitted from Fig. 4 but the rolls and turning bar carried thereby are shown. The deflecting rolls 25 and 26 are carried by laterally pivotable levers 22 and 23 respectively which are hingedly interconnected by a connecting member 24. The position of the parts 22 to 26 in Fig. 4 corresponds to that which they assume in one of the limiting positions of oscillation. The corresponding positions of the rolls 25 and 26 in the other limiting position of oscillation is indicated at 25¹ and 26¹, respectively. To avoid a change in the length of film between the

non-oscillatory rolls 16 and 17 during pivoting of the levers 22 and 23, the rolls are set back from the hinge connections of the levers by an amount substantially equal to the roll radius. An abutment at the hinge connection between the levers 23 and 24 ensures that the linkage will not open up to a greater extent than that illustrated.

In the embodiment of Figs. 5 to 7, a tubular plastics film 103 is produced by an extruder 101 and blowhead 102 which, as in the case of the Fig. 1 embodiment, are located at floor level in a factory. The film is flattened by plates 104 and taken up by haul-off rolls 105 driven by a motor 106. The flattened film 107 is turned through 90° (see Fig. 7) by being passed over a non-rotary turning bar 109 which is inclined at 45° to the longitudinal axis of the unflattened film 103. Thereafter the film 107 is led over a pair of direction-changing rolls 110 to a direction-changing roll 117, to a second non-rotary turning bar 118 which is inclined at 45° and to a direction-changing roll 119. The rolls 117 and 119 as well as the turning bar 118 are carried by a non-oscillatory support 115. After leaving the roll 119, the film is passed over one or more guide rolls 120 to a winder 121.

The haul-off rolls 105, turning bar 109 and pair of direction-changing rolls 110 are mounted on an oscillatory turntable 111 which is supported by a ball bearing race 112 on an elevated platform 113 in the factory and is oscillated by a motor 114. As in the case of the previously described embodiment, the electrical and any pneumatic connections and reversing contacts are omitted from Figs. 5 to 7 for clarity.

On the side of the turning bar 109 opposite to where the pair of direction changing rolls 110 is located, the turntable 111 carries a deflecting or diverting roll 116 which protects the film from interference with the turning bar when the turntable is at its single dead centre or limiting position of oscillation. The position of the roll 116 at such dead centre position of oscillation is indicated at 116¹ in Fig. 6 in which the parts 112, 106 and 114 are omitted for clarity. The course of the film 107 shown in chain-dotted lines in Fig. 6 corresponds to an intermediate position of oscillation of the turntable.

The maximum possible angle of oscillation in the Figs. 5 to 7 embodiment is more nearly 360° than in the Figs. 1 to 3 embodiment because the turning bar 109 is now located centrally above the haul-off rolls 105 whilst the direction-changing rolls 110 as well as the deflecting roll 116 are adjacent the turning bar on the turntable 111. This ensures that during rotation of the turntable account need not be taken of a fixed path for travel of the film; instead, the film is moved to and fro during oscillation of 130

the turntable such that it does not interfere with any of the parts that oscillate through 360°. Since the distance between the pair of direction-changing rolls 110 and the stationary components 117, 118 and 119 varies constantly during oscillation of the turntable, the length of the path travelled by the film 107 will also vary. This leads to irregularities in the speed of the film supplied to the winder 121 over the parts 117, 118 and 119, the film being alternately accelerated and decelerated as compared with its speed at the haul-off rolls 105. However, since the turntable 111 oscillates only very slowly, the speed variations are quite small. With one turn of the turntable in twenty minutes and a turning circle diameter D of 1 meter, the speed variation of the film v_a will be

$$\pi D/20 = 3.14 \times 0.05 = 0.157$$

meters per minute. The percentage speed variation f is given by $v_a \times 100/v_h$, where v_h is the haul-off speed.

For the following haul-off speeds, the percentage speed variations will therefore be as listed:—

v_h (m/min)	Speed variation (%)
10	±1.56
15	±1.04
20	±0.78
25	±0.62

These variations are compensated by the winder drive which preferably employs a slip clutch. Compensation is also possible by means of a dancer roll or the like.

For particularly wide films, the weight of film with large distances between the pair of direction-changing rolls 110 and the direction-changing roll 117 may give rise to difficulties in guiding the film in its upright position, namely to sagging. To avoid this, the apparatus may be provided with two levers 122, 123 and a direction-changing roll 124 (see Fig. 8). The roll 124 is mounted at a position where the levers 122 and 123 are hinged to one another. The other ends of the levers are connected to the pair of rolls 110 and the stationary direction-changing roll 117, respectively. This construction provides the additional advantage of avoiding speed variations of the film between the rolls 105 and the winder 121 because the film path is of constant length.

Having regard to the provisions of Section 9 of the Patent Act, attention is directed to the claims of Patent No. 1,202,359.

WHAT WE CLAIM IS:—

1. Flattening and haul-off apparatus for

blown tubular plastics film produced on a stationary blowhead, comprising flattening means and haul-off rolls mounted for oscillation about the longitudinal axis of the arriving tubular film, a turning bar for the film located downstream of the haul-off rolls and disposed at substantially 45° to the axis of oscillation, a first direction-changing roll for the film located downstream of the turning bar and disposed substantially parallel to the axis of oscillation, the turning bar and first direction-changing roll both being mounted to oscillate with the haul-off rolls, and a non-oscillatory second direction-changing roll located downstream of the first direction-changing roll and disposed substantially parallel to the said axis of oscillation.

2. Apparatus according to claim 1, wherein the turning bar, said first direction-changing roll and a third direction-changing roll that is parallel to the haul-off rolls and located upstream of the turning bar are mounted eccentric to the axis of oscillation and wherein the second direction-changing roll is one of a pair of rolls defining a nip or gap that is substantially in line with the axis of oscillation.

3. Apparatus according to claim 1, wherein the turning bar is located above the haul-off rolls, the first direction-changing roll is one of a pair of rolls adjacent the turning bar and the second direction-changing roll is located eccentric to the axis of oscillation.

4. Apparatus according to claim 3, including a film winder which is driven through a slip clutch for compensating fluctuations in film speed downstream of the first direction-changing roll.

5. Apparatus according to any preceding claim, wherein the turning bar is non-rotary and has a low friction surface.

6. Apparatus according to any preceding claim, including a second and stationary turning bar located downstream of the second direction-changing roll and disposed at substantially 45° to the axis of oscillation.

7. Apparatus according to claims 2 and 6, wherein oscillation takes place through substantially 360° and deflecting rolls for deflecting the film prior to the dead centre positions of oscillation are provided downstream of the second direction-changing roll and upstream of the second turning bar.

8. Apparatus according to claim 3, including a deflecting roll for the film mounted for rotation and oscillation adjacent the turning bar on the opposite side thereof to the said pair of rolls.

9. Apparatus according to claim 3, including a dancer roll or similar film take-up device located downstream of the second direction-changing roll and upstream of a film processing or winding apparatus.

10. Apparatus according to claim 3, including a further direction-changing roll parallel to the said pair of rolls and located downstream thereof and upstream of the second direction-changing roll, wherein the said further roll is mounted at the location of a hinge connection between two levers which are respectively pivoted to the first and second direction-changing rolls.
- 5
- 10 11. Flattening and haul-off apparatus for blown tubular plastics film substantially as hereinbefore described with reference to the accompanying drawings.

For the Applicants,
D. YOUNG & CO.,
Chartered Patent Agents,
9, Staple Inn,
London, W.C.1.

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Fig. 1

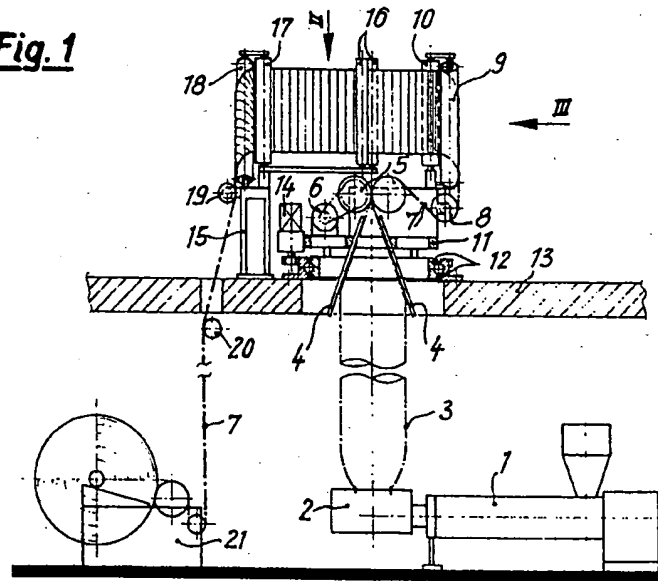


Fig. 2

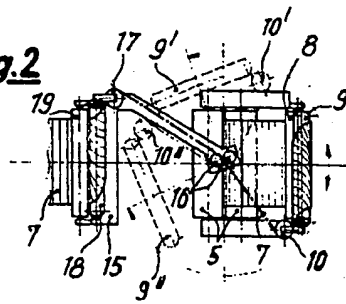


Fig. 3

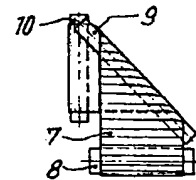


Fig. 4

